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Net Economic Value of Recreational Steelhead Fishing in Idaho

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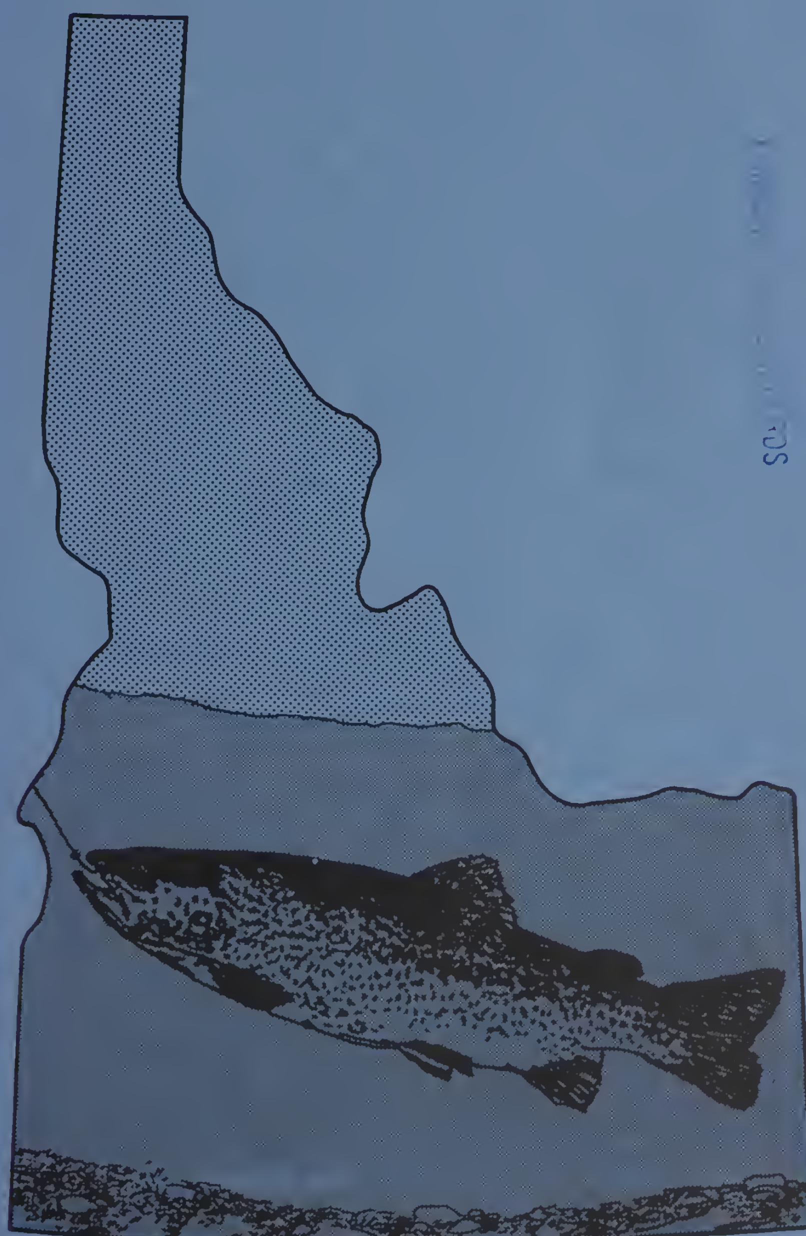

Abstract

Average willingness to pay in addition to actual expenditure for steelhead fishing in Idaho was estimated at $27.87 per trip with the Travel Cost Method and at $31.45 per trip with the Contingent Value Method. Willingness to pay was greater for increased catch or fish size. Average actual expenditure was $72 per trip.

Acknowledgement

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Net Economic Value of Recreational Steelhead Fishing in Idaho

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MANAGEMENT IMPLICATIONS

Recreation associated with wildlife clearly has economic value. However, opinions on the nature and level of this economic value vary widely. This bulletin analyzes the value of steelhead fishing trips in Idaho, using both consumer surplus and expenditure as components of total value for consumptive use of the steelhead resource. Other types of value presumably exist for nonconsumptive uses.

Consumer surplus values generally are useful in analyses of the economic efficiency of resource allocation. An example is a decision about the relative economic efficiencies of two projects, such as improving natural steelhead habitat, or alternatively, easing the spawning run by construction of fish ladders. In contrast, expenditure data are useful for analyses about sectors of an economy, but are not appropriate or relevant for decisions involving the economic efficiency of resource allocation. Therefore, this analysis explicitly focuses on consumer surplus benefits (i.e., values useful in economic efficiency analyses), although some expenditure information is reported.

The estimated average net economic value (or consumer surplus) of a steelhead fishing trip in Idaho is $27.87. This is the value to both the angler and to society. This means that the average angler would be willing to pay an additional $28 per trip to continue to have these sites available for steelhead fishing in Idaho. This value was derived by the Travel Cost Method (TCM) — a demand curve estimating technique. The TCM statistically infers the amount that an average angler would bid if given the opportunity.

It is important for managers, analysts, planners, and others using this and the other information in this bulletin to note its exact nature. The value of a steelhead fishing experience on a per trip basis is a weighted average over all steelhead fishing sites in Idaho. The weighting is on the basis of number of trips to each site. Those sites with more visits, and consequently more consumer surplus, contribute relatively more weight to the average value.

The gross value is the sum of the consumer surplus value plus the expenditures. Thus, the gross consumptive value per trip is the sum of the efficiency value, $28, plus expenditures of $72 per trip, yielding a gross or total value of $100.

Appropriate consumer surplus trip values for a given decision context and scope can be converted to a value per 12-hour Wildlife and Fish User Day (WFUD). Converting trip values to a WFUD value is based on number of days fished per trip and the number of hours fished per day. The value of a WFUD of steelhead fishing is $30.

While the values just discussed are based on the TCM, the Contingent Value Method (CVM) also was used in the study to elicit "simulated market bids" from anglers. This CVM approach was used to measure the net economic value of the last trip by anglers taken during the 1982 steelhead season. The CVM value per trip was $31.45 for current conditions associated with steelhead fishing. This value per trip converts to $45.60 per WFUD for steelhead fishing.

Although the base values, as measured by TCM and CVM, are approximately the same, this correspondence does not necessarily apply to incremental changes. CVM surveys can be designed to measure base or incremental values or both. If there is an improvement in fishing opportunities to existing anglers, the net economic value in the short run, as measured by CVM, is typically less than the long-run value of improved steelhead fishing opportunities as measured by TCM. This is because analysis with the results of the TCM shows an increase in fishing trips of about 238% associated with the improvement, i.e., a 100% increase in fishing opportunities. Therefore, much of the benefits from a higher quality fishing experience would accrue to new anglers attracted by increased fishing quality. This result indicates that number of trips (i.e., participation) for steelhead fishing is sensitive to fishing quality, as measured by number of fish caught.

Readers are cautioned that, in general, economic theory shows that marginal values for the steelhead angling experiences are the theoretically correct values to use in decisionmaking concerning economic efficiency. There is at least one exception, noted by Mumy and Hanke (1975). The present study, however, estimates average value per trip, not marginal values. The reason these average values can be applied in analyses where only marginal values should be used is that the functional form of the demand curve used in this study has the unique property that, for consumer surplus, marginal value is equal to average value. (See the appendix for further details.) This property and result do not apply to most other functional forms.

A second caution concerns the geographic scope of analysis where the values shown in this bulletin are appropriate. Because the TCM value is a weighted average over all steelhead sites, the values could appropriately be used to evaluate the economic efficiency of management actions that uniformly affect all steelhead sites.

However, values for an entire region and values for any area of significantly different size are not measurements of the same geographic scope. To the extent that a management action affects selected fishing areas more than others, individual fishing site values, such as those in table 4, may be more appropriate than the overall values in this bulletin. However, an overall consumer surplus value, such as willingness to pay per trip, may be all that is available, and for efficiency analyses, these are more tenable than expenditure values.

Finally, caution is indicated when using fishing experience values in analyses that also incorporate values for other resources (e.g., timber or water). Direct comparisons of values between resources often is misleading, because the type of value (i.e., average or marginal), or its scope is either unknown or forgotten. For example, it would be generally incorrect to compare marginal consumer surplus values for steelhead fishing from a statewide study to average stumpage values for one forest area surrounded by other forest areas, all of which supply timber to local stumpage markets.

INTRODUCTION

The economic value of wildlife is used in land management planning by the USDA Forest Service and USDI Bureau of Land Management. Although the lands or habitats may be managed by the Federal Government, wildlife is managed by the states. Therefore, it is important to coordinate economic value of wildlife for federal plans affecting habitat so they are compatible with state plans for management of individual species.

This bulletin specifically examines the average net willingness to pay for steelhead (*Salmo gairdneri*) fishing,[3] and also provides a consistent set of dollar values that vary by steelhead fishing units. The purpose of this study was to produce theoretically correct values of average willingness to pay (in excess of current expenditures) acceptable to several federal agencies and the State of Idaho. In addition, this study served as a test of the cost effectiveness of using the Travel Cost Method (TCM) and the Contingent Value Method (CVM) for developing values useful for the 1990 Resources Planning Act (RPA) effort conducted by the USDA Forest Service.

METHODOLOGY

Definition of Economic Value

Economic value used in studies of economic efficiency is measured by the net amount in excess of their actual expenditures that consumers are willing to pay for a resource. Net willingness to pay is the standard measure of value in benefit-cost analysis performed by the U.S. Army Corps of Engineers, Bureau of Reclamation, and the Soil Conservation Service (U.S. Water Resources Council, 1979, 1983). Net willingness to pay is the basis of the values used by the U.S. Forest Service in its local and national planning efforts. The Bureau of Land Management applies willingness to pay measures as the value of all outputs in SAGERAM analysis.[4]

Use of actual expenditures by hunters and anglers is not appropriate for valuation of wildlife or other resources (Knetsch and Davis 1966). Expenditures are useful only for measuring the effect or impact on local economies of some resource management action.

Techniques for Measuring Net Willingness to Pay

Dwyer et al. (1977), Knetsch and Davis (1966), the U.S. Water Resources Council (1979, 1983), and Walsh (1983) all recommended the Travel Cost Method (TCM) and the Contingent Value Method (CVM) as conceptually correct techniques for estimating users' net willingness to pay.

The TCM relies on variations in travel costs of recreationists to trace out the demand curve. The area under this demand curve but above actual travel costs is a measure (called consumer surplus) of net willingness to pay (Clawson and Knetsch 1966, Dwyer et al. 1977).

The CVM asks users directly to indicate their net willingness to pay. This willingness to pay is expressed in the form of bids for specified recreational conditions (Brookshire et al. 1980). Survey design is a critical factor in this method.

Travel Cost Method

This study constructed a Regional Travel Cost Model (RTCM) with trips per capita as the dependent variable. The traditional "per capita" specification was used to adjust for population differences between counties of visitor origin. As Brown et al. (1983) showed, trips per capita takes into account both the number of visits as a function of distance and also probability of visiting the site as a function of distance.

The list of possible independent variables include a surrogate for price (i.e., distance) and also fishing site characteristics, measures of substitutes, and demographic characteristics of fishermen. Given the constraints on length of the angler survey and the limitations on time for data analysis, a relatively simple RTCM was estimated. The basic model follows.

$$\frac{\mathrm{Trips}_{ij}}{\mathrm{Pop}_i} = b_0 - b_1\mathrm{DIST}_{ij} + b_2\mathrm{QUALITY}_j - b_3\mathrm{SUBS}_j + b_4\mathrm{INCOME}_i \quad [1]$$

where

DIST = round trip distance from county of residence, i, to fishing site j.

QUALITY = a measure of fishing quality at site j.

[3] *The net economic value of general cold and warm water fishing is the subject of a separate manuscript by the authors.*

[4] *Bureau of Land Management. 1982. Final rangeland improvement policy. Washington Office Instruction Memorandum No. 83-27, dated October 15, 1982.*

SUBS = a measure of the cost and quality of substitute fishing sites relative to the one under consideration, i.e., site j.

INCOME = a measure of the ability of households in county of residence, i, to incur costs for recreation; serves as a proxy for other taste variables.

b_0 to b_4 = coefficients to be estimated; the algebraic signs indicate the expected relationship of each independent variable with trips per capita.

Equation [1] specifies the per capita demand curve for the fishing sites in the region. By setting the quality measure at a value associated with a specific site, the general RTCM demand curve becomes the demand curve for that specific site. Therefore, recreation visitation patterns for all sites in the region can be modeled with one equation. Equation [1] states that trips per capita from origin i to site j is a function of the distance from origin i to site j, quality of site j, the substitute sites available to origin i, and the income of residents of origin i. Once the per capita demand curve for each origin-site combination is specified, a more aggregated demand curve is calculated. This aggregated demand curve for a site, the so-called "second-stage" demand curve, relates total trips to a site as a function of hypothetical added cost, as measured by distance. Once the hypothetical added distance is converted to travel costs (in dollars), the area under the second stage demand curve represents net willingness to pay. Willingness to pay is a net value, because only the hypothetical added cost is reflected in the second stage demand curve, not the original travel costs (Clawson and Knetsch 1966, Dwyer et al. 1977).

Finally, the total consumer surplus for all sites, as measured by net willingness to pay, can be converted to economic value per trip by dividing by the number of trips taken at zero added cost. Consumer surplus per day also may be computed by dividing consumer surplus per trip by estimated average days per trip for the recreationists sampled.

The estimate of net willingness to pay is the end result of a series of mathematical and statistical operations on the aggregated data. One item of interest about estimated net willingness to pay is the sensitivity of this estimate to variation within the travel cost data. This variation is evident in the standard error of the regression and in the computed statistical confidence interval associated with the estimate of each coefficient of the visits per capita regression model (i.e., the first stage demand curve).

Conceptually, this variation is carried through all the steps described previously, including formation of the second stage demand curve and the subsequent integration under it. Thus, it is logical to consider variation associated with estimated net willingness to pay per trip. However, the statistical properties of the confidence interval estimates of net willingness to pay are not yet completely developed.[5] Despite this, certain aspects of sensitivity may reveal information about the variability of benefit estimates. Specifically, for this research, a "sensitivity interval" was defined. This interval, for estimated benefits measured by willingness to pay, describes the upper and lower bounds of the benefit estimate when the regression coefficient of distance is varied to the upper and lower bounds of its confidence interval.

For example, the computer program that calculates benefits is run three times—once with the distance coefficient at its best unbiased level, once with it at the lower level of its 95% confidence interval, and once with the distance coefficient at the upper level of its 95% confidence interval. The three estimates of benefits related to steelhead fishing respectively indicate how benefits vary with respect to variation in the coefficient associated with distance. Distance was chosen specifically, because increased increments of this independent variable measure additional cost hypothetically incurred by anglers. Later in this bulletin, these sensitivity intervals are compared to the confidence intervals derived from contingent valuation. This comparison is not a statistical procedure; but it provides an indication of the relative ranges in estimates produced from each method.

[5]*Personal communication to Dennis M. Donnelly from Rudy M. King, Biometrician, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo. 80526.*

Contingent Value Method (CVM)

The CVM is also known as the "direct method," because the interviewer directly asks the recreationists what they would be willing to pay to fish at a particular site. The object is to determine the net willingness to pay of an individual for fishing at a site, relative to some alternative site. The issue is not the value of fishing itself. An alternative typically valued involves the addition or elimination of one or more sites, not the elimination of fishing in general. While CVM relies on responses to hypothetical questions, research by Bishop and Heberlein (1979) and Brookshire et al. (1982) indicates that rather than overstatement of willingness to pay, CVM generally provides conservative estimates.

CVM is implemented with a bidding game approach. Researchers from the state of Idaho chose an "iterative" technique implemented by means of a telephone interview. The iterative technique involves repeatedly asking the person if he would pay successively higher and higher amounts of money. Once the person reaches the maximum amount he would pay, this final value is recorded.

Another aspect of presurvey design is to identify the appropriate "payment vehicle." That is, what payment mechanism is going to be used to elicit the money bid. One can use entrance fees, license fees, taxes, trip costs, or payment into a special fund. In this study, trip cost was used as the payment vehicle because it was fairly neutral and familiar to the respondents. The specific question format with the questionnaire is in the appendix.

One advantage of CVM over TCM is that the researcher can determine willingness to pay, not only for current conditions, but also for hypothetical changes in

fishing quality. This study asked additional willingness to pay for doubling the number of fish caught (versus current catch) and doubling size of the fish (relative to current size). This provides important management information. Although the number of fishermen may or may not increase when fisheries improvements are made, fishery improvements appear to increase the value per day for those who do fish.

Another advantage of CVM is that the value per day associated with fishing on trips that were multipurpose or multidestination can still be estimated. With TCM, one can accurately value only trips for which the primary purpose and primary destination was for fishing. Therefore, this study was able to present the value of steelhead fishing for both types of trips.

The analysis of CVM results is straightforward. Generally the mean willingness to pay is calculated once outliers and protest bids are removed. It should be noted that question design is vital to obtaining a true CVM measure of value. Because CVM is based on a direct measure of value, a poor survey design will render useless results. This means including a protest mechanism in the survey. This mechanism allows differentiating between legitimate bids and bids made in protest to the survey itself, not to the resource in question.

Before calculating mean willingness to pay, the data must be screened to remove outliers. In this study, individual bids greater than $100 were analyzed in conjunction with other data reported by individuals such as total days of fishing, total hours fished, and origin-destination information. A judgment then was made as to whether or not the bid was appropriate. For example, the likelihood is low that an angler would bid in excess of $100 for a trip to an area where total length of stay was short. If an angler's bid did not fit the statistical properties of other bids in its range and was greater than $100, it was discarded as suspect.

SURVEY DESIGN AND IMPLEMENTATION

The population sampled in the survey that preceded this study was anglers having an Idaho steelhead tag in 1982, including both residents and non-residents. The sampling rate was 1.69% or 427 individuals selected randomly. This is more than double the minimum sample size suggested by the U.S. Water Resources Council (1979).

The 427 anglers first received a letter of introduction from the University of Idaho's College of Forestry, Wildlife and Range Sciences. The letter indicated that someone from the University would be calling to collect the information requested, such as trips to the steelhead fishing units identified on an enclosed map (fig. 1). The map was included to help respondents identify locations or sites which were visited during 1982. Each individual then was asked to list his trips before he would be contacted by telephone, so that the answers could simply be read during the phone conversation. In that same telephone interview, additional questions were asked oriented to both TCM and CVM analyses.[6]

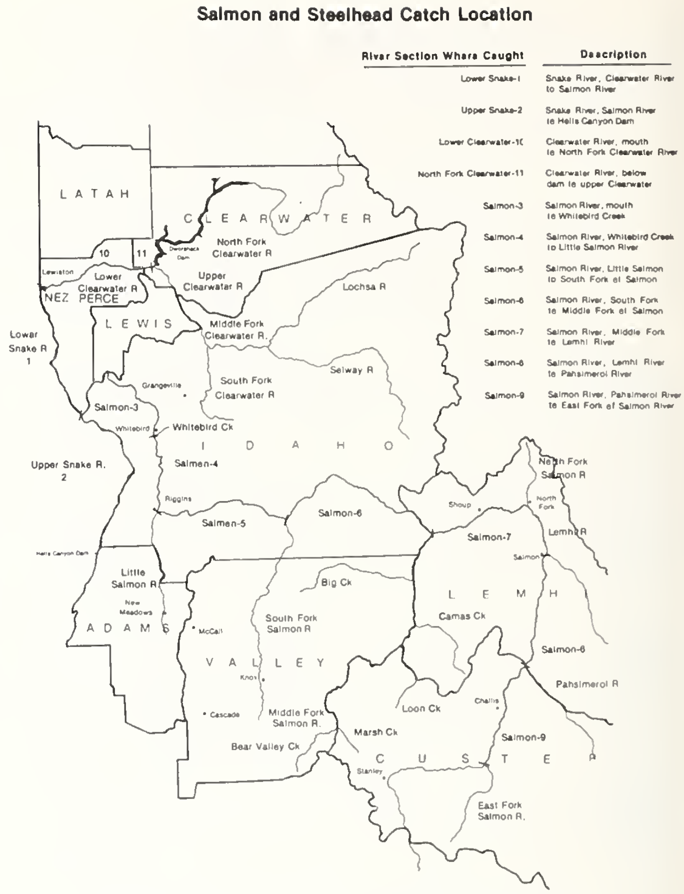


Figure 1.—Salmon and steelhead catch locations.

The survey was designed to determine trip information, such as number of people in each fishing party, fishing quality, and fish species sought. For the Travel Cost Model analyses, trips were screened to insure that fishing was the primary purpose and that the particular site was the primary destination. As explained previously, the intent was to eliminate from the TCM analyses visits that were not primarily for steelhead fishing. The bidding questions for CVM were asked with regard to the last trip to estimate the value of that trip regardless of whether its primary purpose was fishing.

The respondents were asked to report the round trip distance traveled to each site that was visited. This variable became the price variable. While Brown et al. (1983) noted that recall of distance may be in error, they also noted that use of zonal TCM minimizes the effect of the error on coefficient estimates. The reason is that by using the mean of reported distances, extreme responses are given less weight in the zonal method than in the individual observation approach.

[6]*Lloyd Oldenburg and Lou Nelson of the Idaho Department of Fish and Game, developed the combination mail and telephone surveys. The actual telephone survey was performed during the months of April and May 1983, by personnel at the University of Idaho under the supervision of Lou Nelson, then with the University of Idaho. This approach obtained a 100% response rate. For purposes of complete information, the text of the survey instrument is reproduced in the appendix.*

The usual alternative to relying on respondent's estimates is to compute distance as part of data analysis. This procedure depends on knowledge of respondent origin and site visited, and on supposition about the probable travel route. While this approach is potentially more accurate, it is also more time consuming and costly. And, in the absence of exact route information, these estimates may also include error. Thus, because one purpose of our approach to this study was to investigate cost-effective analysis techniques, the study design did not include computation of distance from maps or other exogenous information sources.

STATISTICAL ANALYSIS

Data Compilation

There were two basic phases to the analyses of the Idaho Steelhead data. First, the mean net willingness to pay (WTP) was determined from the CVM bid data. Because this required just a few days of total work, CVM is attractive as a methodology for rapid evaluation of wildlife benefits. In addition, the capability to value different situations including trips with multiple purposes and changed conditions is another asset of CVM.

Second, TCM analysis was initiated concurrently with the CVM analysis. The individual data cases were scanned to find data coding errors. To be able to derive visits per capita to a specific fishing site from a particular origin, the individual cases were grouped according to counties or, in some cases, county groups. Trips per capita for the sample from each county of visitor origin was calculated by dividing trips from a county by that county's population. Once the data were aggregated, measures of substitute site attractiveness and site quality were calculated. Past approaches used externally derived information about physical characteristics of the site under study and about substitute sites. Because this analysis was a prototype to evaluate the cost-effectiveness of TCM, substitute and quality measures were limited to those which could be derived from the data in the survey.

The substitute measure used in the final regressions was total fish catch at each of the alternative sites divided by that site's respective distance from a given origin. The numerator was taken as a measure of site quality to fishermen. The distance variable related to the cost of obtaining this level of fish catch. Therefore, the substitute measure was, in essence, fish per mile. For a given origin-fishing site combination, the substitute site was that fishing area, other than the one actually visited, that had the largest ratio of fish caught per mile traveled, compared to all other sites visited from that origin.

Several site quality measures were formulated to reflect fishing quality. Fish per hour, although the most logical candidate, proved to be statistically insignificant in all regression equations. Instead, total fish catch at the site was found to be statistically significant. This variable allows better identification of an individual site when using a Regional Travel Cost Model. The total fish catch variable can be used to estimate the economic efficiency benefits (in a Benefit-Cost sense) of any actions taken to increase total fish caught.

County per capita income also was tested as a variable, because economic theory indicated that it influenced the ability of county residents to purchase trips to a recreation site.

Regression Analysis

In the regression analysis, variables that were consistently insignificant were dropped from further consideration. Functional form, however, was not as easy to determine.

The model in equation [1], previously discussed, was the simplest formulation. In addition, several alternative models were proposed:

$$\ln(\text{Trips/pop}) = b_0 - b_1\text{DIST} + b_2\text{TOTFISH} - b_3\text{SUBS} \pm b_4\text{INC} \pm b_5(\text{INC})^2 \qquad [2]$$

$$\ln(\text{Trips/pop}) = b_0 - b_1\text{DIST} + b_2\text{TOTFISH} - b_3 \ln(\text{SUBS}) \pm b_4\text{INC} \pm b_5(\text{INC})^2 \qquad [3]$$

$$\begin{aligned}(\text{Trips/pop})(\sqrt{\text{pop}}) = {} & b_0\sqrt{\text{pop}} - b_1[\ln \text{Dist}](\sqrt{\text{pop}}) \\ & + b_2\,\text{TOTFISH}(\sqrt{\text{pop}}) - b_3\text{SUBS}(\sqrt{\text{pop}}) \\ & \pm b_4\,\text{INC}(\sqrt{\text{pop}}) \pm b_5(\text{INC})^2(\sqrt{\text{pop}})\end{aligned} \qquad [4]$$

where DIST = Round-trip distance from a particular county of residence to a particular fishing site.
TOTFISH = Total fish caught at the fishing site.
SUBS = The maximum of the ratios of TOTFISH for a given site under study to DIST from the origin under study to all the other sites visited from the origin under study.
INC = As defined earlier for income.

Equations [2] and [3] adopt the functional form that several economists have argued is most plausible. Ziemer et al. (1980), Vaughan and Russel (1982), and Strong (1983) contended that because of the pattern by which trips per capita fell off at higher distances, the natural log of visits per capita was preferred to either a linear functional form or natural log of distance as in equation [4]. Their point was that with these latter two functional forms negative visits would be predicted for a few high cost zones. They felt that negative visits were contrary to intuition which, therefore, provided credence for the natural log of visits per capita.

Income and income-squared was used, because Martin et al. (1974) found that income did not necessarily enter in a linear fashion. For example, an hypothesis is that increased income is associated with increased fishing activity, but perhaps the relationship is not linear. In addition, increases in income may allow nonparticipants to become anglers, thereby increasing overall use. However, income did not enter strongly into the analysis. Fishing may be a "normal good" for some and an "inferior good" for others. Goods for which purchases rise with income are "normal goods." Goods for which pur-

chases fall as income rises are called "inferior goods." This latter term does not denote inferiority. Rather, it refers to a relationship between quantity demanded and income.

For a linear functional form, Bowes and Loomis (1980) argued that the unequal geographic sizes of population zones require a weighting factor that is the square root of population (equation [4]) to avoid heteroskedasticity (heterogeneous variances), thereby improving both benefit and use estimates. Vaughan and Russel (1982) and Strong (1983), however, showed that if the log of visits per capita is chosen as the functional form (equations [2] and [3]), the heteroskedasticity will be so greatly reduced that weighting by square root of population may be unnecessary.

In part, the choice of functional form depends on whether use or benefit estimation is the critical factor in the study's objectives. In this study, benefit estimation was most critical. However, the conclusions about functional form depend on characteristics of specific data bases. Several criteria important in deciding on the relevance of the regression were examined. First, the Regional Travel Cost Model was to estimate benefits accruing from an existing set of sites, not estimates of use at a new site. Therefore, goodness-of-fit of the model was tested according to the procedures developed by Rao and Miller (1965)[7] to determine whether the natural log of visits per capita or natural log of distance performed best. These test statistics indicated natural log of visits per capita was better. Second, examination of the residuals showed a random pattern well spread out in terms of positive and negative values and runs of sign. Finally, estimated visits were compared with actual visits. If estimated visits were fairly close to actual visits (± 10%), the natural log of visits per capita was used instead of Bowes-Loomis weighting.

Calculation of TCM Benefits

To calculate benefits with distance as the price variable using the second stage demand curve approach, it is necessary to convert distance to dollars. Travel costs to a site consist of transportation costs and travel time costs. Travel time is included because, other things being equal, the longer it takes to get to a site the fewer visits will be made. That is, time is so often a limiting factor and acts as a deterrent to visiting more distant sites. Omission of travel time also biases the benefit estimates downwards (Cesario and Knetsch 1970, Wilman 1980).

[7] *The essential problem in comparing goodness of fit for two regressions like these with differing functional forms is that comparing the residual sums of squares to determine which has the lesser value is not valid, because the unit of measurement rather than the functional form is the operative factor in decreasing the sum of squares. However, by standardizing the variables so that variance does not change with measurement units, the two forms may be compared. The comparison of each equation's sum of squares is done by means of a nonparametric ratio test on the sums of squares. The test statistics follows a chi-square distribution with one degree of freedom (Box and Cox 1964). When the test statistic is greater than the chosen critical value, the null hypothesis that the two functions are empirically similar may be rejected.*

The value of travel time was set at one-third of the wage rate as prescribed by the U.S. Water Resources Council (1979, 1983). This is the mid-point of values of travel time that Cesario (1976) found in his review of the transportation planning literature. However, the use of one-third the wage rate is not necessarily intended to measure wages foregone during the time spent traveling, but instead, includes the deterrent effect of scarce time on the decision of which sites to visit. This study used the U.S. Department of Labor estimate of a median wage of $8.00 per hour because estimates of individual angler income were not collected. One-third of this is $2.67 per hour. For all anglers sampled, the average opportunity cost of time spent traveling was about $0.066 per mile. It would have been desirable to use the actual wage rate for steelhead anglers rather than this $8.00 average wage, because steelhead anglers may have different incomes than the national median.

This study computed transportation costs in three steps. First, mileage was converted to transportation cost on a per vehicle basis. This was done using variable automobile costs, such as gasoline. An intermediate vehicle size class was taken as typical and had a cost of 13.5 cents per mile in 1982 (U.S. Department of Transportation 1982). Second, with about 2.6 anglers per vehicle this standard cost per person was about $0.05 per mile. Figures for pickup trucks were not available.

Finally, the transportation cost also was estimated using the cost per mile reported by survey respondents for their last steelhead fishing trip rather than the cost per mile of $0.135 reported by the Department of Transportation (1982). Respondents reported their own share of transportation costs which, when divided by roundtrip miles, equaled $0.10 a mile. This may be a more appropriate value to use, because it is the price perceived by the respondent. That is, the quantity of trips consumed would probably be more closely related to the perceived cost rather than some standardized cost. Also, the Department of Transportation figure used for the standard cost reflected costs of suburban driving with an intermediate size car. Gas mileage on roads paralleling rivers for steelhead fishing may be somewhat different than for suburban travel. More important, if a larger vehicle were driven on these trips (allowing for the possibility for towing a trailer), it might raise the cost far above that of an intermediate size car. Increasing the transportation cost per mile from $0.05 to $0.10 increases total travel cost (including travel time) to approximately $0.16 per mile. Then the quantity of trips made is associated with a higher price per trip, which translates into a rightward shift in the upper portion of the second stage demand schedule. This shift results in an increase in total and, therefore, per trip consumer surplus, because the implication is that people are willing to pay for the same experience at an increased rate. Both standard and reported travel costs are used to provide the most useful information for valuation of Idaho steelhead fishing and to allow comparison to other studies.

The transportation cost and value of travel time are added for each increment in distance and for the

amount of time required to travel that distance increment. This rescales the vertical axis of the second stage demand curve from miles to dollars of travel cost. The area under the second stage demand curve yields estimated consumer surplus for the sampled anglers. Dividing this quantity by trips yields mean consumer surplus per trip.

RESULTS AND DISCUSSION

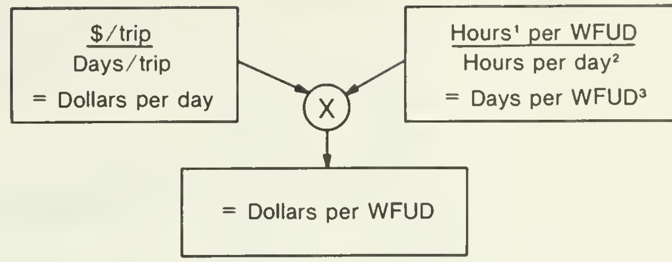
Contingent Value Method

Table 1 provides summary information about the population of steelhead anglers who were asked about their last trip in the CVM portion of the survey.

Primary Purpose Trips

Table 2 presents the dollar values for primary purpose and non-primary purpose trips. The data are for all sites. For primary purpose trips, steelhead anglers are willing to pay $31.45 per trip more than their current expenses rather than not visit their chosen site. This $31.45 is associated with 1.55 days of fishing per trip. The value per day is $20.29. On the basis of a 12-hour Wildlife and Fish User Day (WFUD), the value would be $45.50, because anglers fished 5.34 hours per day. The details of this computation are shown in fig. 2. In addition, anglers caught an average of 0.95 fish per day and fished 1.55 days each trip, so on the average, they caught 1.47 fish each trip. This yields an average value of $21.39 per fish harvested.

The estimates of fish caught per day from this survey are higher than reported in past Idaho Game and Fish Surveys. This may be because 1982 was a good year for



[1]Hours per WFUD - Defined as 12.

[2]Hour per day spent in the activity, in this case, fishing.

[3]WFUD - Wildlife and Fish User Day.

Figure 2.—Calculation of dollars per day and per WFUD.

steelhead fishing. Also past reports have spring-fall seasonal averages, whereas the estimates in this study were based on catch for the last trip. If actual fish catch per day were closer to lower historical levels, the value per fish harvested would be higher. However, one cannot simply divide the existing value per trip by the lower catch to calculate this new value per fish, because the value bid per trip in the CVM approach would fall if actual fish catch were lower.

Asking anglers about changed fishing conditions provides some economic values useful for fisheries management. If anglers were able to double number of steelhead caught, bids per trip increased from $31.45 to $41.36. Doubling the number of fish caught means increasing fish catch to nearly three per trip. So, to existing anglers, the $9.91 increase is the value per trip for catching twice the number of steelhead and, is equivalent to $6.74 per extra fish. Thus, if managers wish to consider

Table 1.—Survey Summary Statistic for CVM.

	Mean	Median	Minimum-maximum	Sample size
Distance (miles)	217.77	100.11	1.0 to 1000	481
Number of days fishing	1.55	1.09	.5 to 10.00	311
Number of hours fished per day	5.34	5.19	.5 to 12.0	311
Number of fish caught per day	.95	.50	0 to 12.0	263
Number of licensed anglers	2.63	2.36	1.00 to 8.00	311
Cost of travel	$33.15	15.38	0 to 700	338
Variable cost (food, tackle, etc.)	$33.86	14.85	0 to 700	338
Cost of accommodations	$12.73	[1].074	0 to 700	271

[1]The median value is low because 236 out of 271 individuals reported zero cost for accommodations.

Table 2.—Net willingness to pay and profile of steelhead anglers as estimated by CVM for their last trip

	Primary purpose	Non-primary purpose
Net willingness to pay (bid) for current conditions per trip	$31.45 [1]3.11 [2](258)	$45.71 26.38 (7)
Net willingness to pay in excess of bid for current conditions for double number of fish caught per trip[3]	$9.91 7.33 (257)	$11.43 6.70 (7)
Net willingness to pay in excess of bid for current conditions for 50% increase in fish size[3]	$7.69 1.19 (258)	$2.28 2.14 (7)
Days fishing on this trip	1.55 (311)	2.39 (8)
Hours fished per day on this trip	5.34 (311)	4.50 (8)
Fish caught per day on this trip	.95 (263)	2.57 (7)
Number of licensed anglers on this trip	2.63 (311)	3.75 (8)
Cost (travel, food, tackle, accommodations, etc.)	$72.21 (247)	$157.13 (8)

[1]*Standard error for each CVM mean bid is shown just beneath each bid.*

[2]*Of the 344 interviewed in CVM, 24 refused to put a dollar value on steelhead fishing. (Numbers in parenthesis are sample sizes.)*

[3]*To compute the total bid for each contingent change, add the amount bid for the change to the amount bid for current conditions. For example, the total bid for double the number of fish caught for primary purpose trips is $41.36 (=31.45 + 9.91).*

increasing fish populations, the value of extra fish caught may be helpful in establishing the associated economic benefits.

In addition, the net willingness to pay was worth $7.69 per trip for increasing the average size of steelhead by 50%. This benefit could be compared to the costs of managing for habitat conditions that would allow fish size to increase by 50%.

While the benefit estimates for primary purpose trips may appear low, the reader must keep in mind what is being measured. The benefits are net willingness to pay in excess of expenditures. Table 2 shows that the sum of net willingness to pay and cost (i.e., gross willingness to pay) is quite high—more than $100 per trip. Because of the high cost of trips associated with remoteness of certain segments of the Salmon River and other steelhead areas, the amount over cost anglers are willing and able to pay is lower than might be expected. However, the figure of $31 a trip translates to $20.29 per day, a value not too different from the willingness to pay value of $18.00 per day for ocean salmon/steelhead fishing reported by Crutchfield and Schelle (1978).

Table 3 provides values for the Clearwater River (Sections 10 and 11 in figure 1) and the Salmon River (Sections 3–9 in figure 1). Net willingness to pay for steelhead fishing in the Salmon River was higher, even though number of fish caught was similar for both rivers. The difference in value may partly relate to the resource setting in which the fishing takes place. Access for anglers to the Clearwater River is easier than for the Salmon River. Expenditures also were different, which may be useful for regional economic analysis. A later section discusses the 11 river segments studied.

Multiple Purpose Trips

Multiple purpose trips could not be analyzed using Travel Cost Method, because it would be incorrect to attribute the distance driven to the site as an indirect measure of price paid for fishing. The net willingness to pay for multiple purpose steelhead fishing trips using CVM was $45.71 per trip. This translates to $19.12 per day and to $51.00 per 12-hour WFUD. This group was not large. The sample showed that only 3% of steelhead anglers were fishing as part of a multiple purpose trip.

There are two possible reasons why multiple purpose trips had such high values. First, these values may not really be representative of such trips, because the sample was so small. Second, if the travel expenses were already incurred for other purposes (e.g., business, family), then the extra costs of steelhead fishing may

Table 3.—Net willingness to pay and profile of steelhead anglers as estimated by CVM for two rivers.

	Primary Purpose Trips	
	Clearwater	Salmon
Net willingness to pay (bid for current conditions per trip	$23.63 [1]3.86 [2](84)	$37.84 5.18 (123)
Net willingness to pay in excess of bid for current conditions for double number of fish caught per trip[3]	$7.64 1.31 (98)	$3.60 2.03 (126)
Net willingness to pay in excess of bid for current conditions for 50% increase in fish size[3]	$5.69 1.23 (99)	$9.63 2.14 (126)
Days fishing on this trip	1.20 (117)	1.81 (151)
Hours fished per day on this trip	5.30 (117)	5.33 (151)
Number of fish caught per day on this trip	0.89 (102)	0.95 (127)
Number of licensed anglers on this trip	2.42 (117)	2.71 (151)
Cost (travel, food, tackle, accommodations, etc.)	$38.68 (84)	$96.71 (123)

[1]*Standard error for each CVM mean bid is shown just beneath each bid.*
[2]*Sample size in parenthesis.*
[3]*To compute the total bid for each contingent change, add the amount bid for the change to the amount bid for current conditions. For example, the total bid for double the number of fish caught on the Clearwater is $31.27 (= 23.63 + 7.64).*

have been quite low. If this is the case, the net willingness to pay may be quite high, because the additional cost of steelhead fishing is minimal compared to the cost of the total trip.

Travel Cost Method

The regression equation used to calculate benefits is:

$$\begin{aligned} \ln(\text{trips/pop}) &= -7.60255 - 0.0058734(\text{DIST}) \\ (\text{“t” statistics}):\ & \quad (-28.909) \qquad (-9.839) \\ & \quad - 0.22482(\ln(\text{SUBS})) \qquad [5] \\ & \qquad (-2.881) \\ & \quad + 0.021739(\text{TOTFISH}) \\ & \qquad (2.226) \end{aligned}$$

This equation is highly significant, with an F-value of 33.4. Both the F and the individual t statistics are all significant at the 99% level. The R^2 is 0.44.

The model specified in equation [5] is termed log-linear, because the dependent variable is transformed as shown and the independent variable associated with cost (i.e., distance) is not transformed. This transformation compresses the natural variation found in a completely linear model, resulting in an artificially high multiple correlation coefficient, R^2. Thus, it is not proper to compare a log-linear model to a linear model solely on the basis of R^2.

As discussed earlier, choice of functional form of the per capita demand equation was related to two factors. These were the Rao and Miller (1965) functional form test, and how well the log of visits per capita reduced heteroskedasticity. The Rao-Miller test indicated that log of visits per capita was preferred in terms of better data fit. The log of visits per capita minimized heteroskedasticity to the extent that estimated visits to the 11 sites were 1,811, while actual visits were 1,962. The estimated visits are within 10% of the actual. Because the main emphasis was on benefit estimation, this was deemed acceptable. In addition, the weighted linear regression resulted in neither substitutes nor quality (total fish) being statistically significant. When building a regional TCM for valuation of different sites, substitute and quality variables should be present in the equation, if possible, rather than deleting them to improve the use estimate another few percentage points.

Equation [5] does not contain an income variable because of a very high degree of multicollinearity between income and the substitute variable. The correlation coefficient of income and substitutes was 0.63 for

natural log of substitutes and, 0.74 for untransformed substitutes. The effect of this multicollinearity when both income and substitutes were in the equation was to cause the sign on substitutes to change to positive, which is not plausible, given economic theory about the effect of substitutes on demand. As the quantity (fish-per-mile) of the best substitute site increases, visits per capita to the site under study are expected to decrease. When income was removed from the equation to eliminate multicollinearity (highly correlated independent variables), the sign of substitutes in fact became negative. The regression also was estimated including income but not substitutes. Including income resulted in estimated visits being about one-half of actual visits. In addition, the dollar values per trip derived from the second-stage demand curve were about $2 higher with income in and substitutes out. Given these empirical tests, substitutes were retained in the regression rather than income, because predicted visits were much closer to actual.

The per capita demand curve for steelhead fishing was used to derive a second stage demand curve for each of the 11 steelhead fishing sites. One of the advantages of a regional travel cost model is that one equation can be tailored to specific sites. In this case, the values of the variables for total fish and substitutes distinguish sites apart, so these were set at the appropriate numbers for each origin-site combination. Distance was set at its current value to calculate estimated visits at the mean distance anglers actually traveled from each origin. Then, 50-mile increments were successively added to distance until visits from a particular origin fell to 0.1, or until distance equaled the highest distance actually observed in the data. This maximum observed distance was a 1,000-mile round trip, which occurred in four cases. This distance limit was used as a cutoff point for incrementing distance, because visits per capita would never drop to zero with natural logs (Wennergren 1967, Smith and Kopp 1980). This rule yields a conservative estimate of the surplus, because it cuts off a portion of consumer surplus. However, in this application, the amount of consumer surplus lost was less than $100. In addition, use of this maximum distance implies an empirical boundary to the market area for steelhead fishing in Idaho.

Figure 3 illustrates the second stage demand curve for the most heavily visited site, site 10, the lower Clearwater River. Because the distance increment is computed over and above the current distance, the entire area under this curve (when distance is converted to dollars) is consumer surplus. A simple conversion of added distance to dollars cannot be made on the graph in figure 3, because the conversion of distance to travel cost for a given site incorporates differences in the number of anglers per vehicle from each origin visiting that site. The sample total consumer surplus is $18,070 using a standard cost per person per mile of $0.135. On a per trip basis the value is $19.12. Using the transportation cost reported by sampled anglers, the sample total consumer surplus is $25,617 yielding a consumer surplus per trip of $27.08.

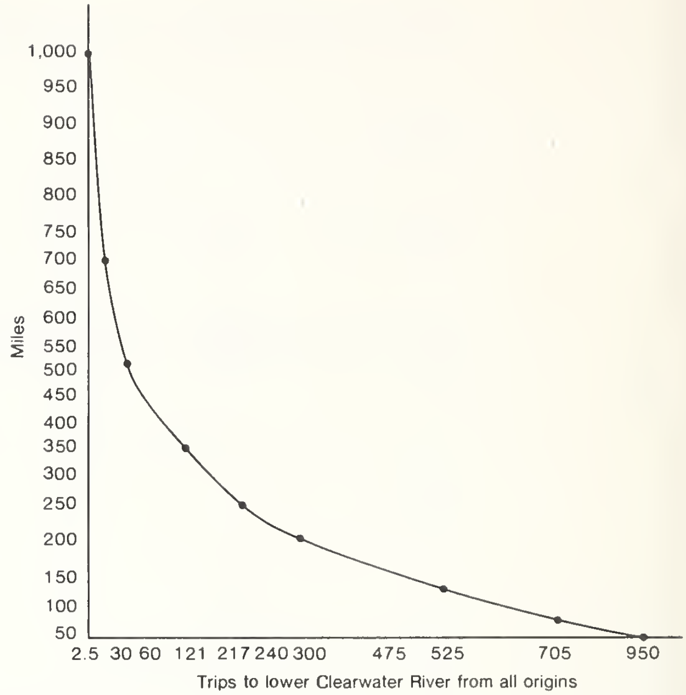


Figure 3.—Second stage demand curve for site 10, Lower Clearwater River.

Average steelhead values from the Travel Cost Method over all 11 sites combined are reported in the following tabulation:

	Standard cost *per mile*	**Reported cost** *per mile*
Net willingness to pay for current conditions per trip	$19.89	$27.87
Number of days fishing on this trip	1.95	1.95
Number of hours fished per day on this trip	5.76	5.76
Values per day	$10.20	$14.29
Value per 12-hour WFUD	$21.28	$29.77

Using a standard cost of $0.135 per mile, the value per trip is $19.89 with a sensitivity interval of $15.27 to $23.38. Using reported transportation cost of $0.26 per mile, the value per trip is $27.87 with a sensitivity interval of $23.12 to $34.82. Table 4 reports TCM values by site. Note, that the total consumer surplus for each of the 11 sites (the two bottom lines in Table 4), is generated by only 1.69% of users. To get a total value for the site, the sample value is expanded by the reciprocal of the sample rate (1/0.0169 = 59.11). Of course, each site's total value depends on the fact that it is part of a system of 10 other sites.

Converting the benefits per trip to benefits per day using estimated length of trip, yields $10.20 per day at the standard cost per mile and $14.29 at reported cost.

Table 4.—Steelhead Fishing Values Derived by CVM and TCM.[1]

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Travel Cost Method @ Standard Cost Per Mile											
Net willingness to pay for current conditions	$19.27	$20.44	$19.92	$18.89	$18.81	$19.68	$20.57	$23.88	$22.52	$19.12	$22.24
Travel Cost Method @ Reported Cost Per Mile											
Net willingness to pay	$26.60	$28.90	$27.88	$25.94	$25.78	$27.46	$29.27	$35.58	$33.00	$27.08	$32.40
Contingent Value Method[2]											
Net willingness to pay for current conditions	$27.83	$35.69	$10.96	$36.57	$25.83	$49.38	$50.98	$24.50	$27.50	$23.66	$19.00
	11.59	12.57	2.38	14.14	8.43	14.15	10.48	15.24	17.50	4.27	8.64
	(18)	(16)	(22)	(14)	(12)	(16)	(50)	(6)	(2)	(83)	(17)
Contingent Value Method											
Net willingness to pay for double number of fish caught	$34.18	$40.88	$18.86	$59.43	$30.50	$58.00	$65.98	$37.17	$42.50	$31.82	$23.18
	11.88	12.10	3.53	14.33	8.23	13.84	12.27	22.75	12.50	5.48	8.96
	(17)	(16)	(22)	(14)	(12)	(16)	(50)	(6)	(2)	(82)	(17)
Contingent Value Method											
Net willingness to pay for 50% increase in fish size	$35.88	$41.00	$16.68	$46.57	$32.08	$69.50	$59.06	$27.17	$32.50	$29.75	$22.06
	13.23	12.14	3.87	15.23	10.12	24.07	10.94	14.69	22.50	4.66	8.55
	(17)	(16)	(22)	(14)	(12)	(16)	(50)	(6)	(2)	(81)	(17)
Number of fishing days on this trip	1.64	1.50	1.15	1.71	1.81	1.81	2.23	1.57	1.50	1.19	1.24
	(22)	(21)	(26)	(19)	(16)	(18)	(57)	(7)	(2)	(99)	(17)
Number of hours fished/day on this trip	5.34	5.67	4.40	5.08	6.06	5.17	5.57	5.29	7.00	5.14	6.12
	(22)	(21)	(26)	(19)	(16)	(18)	(57)	(7)	(2)	(99)	(17)
Number of fish caught/day	.89	1.44	.56	.43	.50	1.75	1.14	.50	1.00	.91	.77
	(18)	(16)	(22)	(14)	(12)	(16)	(50)	(6)	(2)	(84)	(17)
Number of licensed anglers this trip	2.77	3.10	2.58	3.11	3.19	3.11	2.51	1.43	2.00	2.49	1.94
	(22)	(21)	(26)	(19)	(16)	(18)	(57)	(7)	(2)	(99)	(17)
Cost (travel, food, tackle, accommodations, etc.)	$68.24	$66.21	$43.86	$91.33	$145.27	$99.81	$104.09	$87.00	$51.50	$37.32	$36.58
	(21)	(19)	(21)	(15)	(15)	(16)	(43)	(6)	(2)	(71)	(12)
Sample total visits[1]	94	63	73	70	84	137	121	44	14	1,042	65
Total sample net willingness to pay at standard cost	$1,812	$1,287	$1,454	$1,322	$1,580	$2,696	$2,489	$1,050	$315	$19,923	$1,445
Total sample net willingness to pay at reported cost	$2,500	$1,820	$2,035	$1,815	$2,165	$3,762	$3,542	$1,565	$462	$28,217	$2,106

[1]*Sample size in parentheses.*
[2]*Standard error for each CVM mean is shown just beneath each bid.*

Converting these to a 12-hour Wildlife and Fish User Day (WFUD) basis using hours fished per day, yields $21.28 per WFUD for standard cost per mile and $29.77 per WFUD for reported cost per mile.

One use of the RegionaL TCM equation is to predict the change in visits if total fish harvest is increased. As an example, if total fish caught is doubled, the number of primary purpose trips would increase from 1,811 to 6,118.

Comparision of Idaho TCM to Oregon TCM

Generally, it may appear that the steelhead values are low compared to $45 per trip for salmon/steelhead values found by Brown et al. (1980) using TCM. However, the average round-trip distance traveled to steelhead fish in Idaho is 331 miles based on aggregated TCM data, whereas in Oregon it is much lower. The lower mileage in Oregon, and, therefore, the price paid, implies that, even with the same demand curve, greater net willingness to pay could be expected in Oregon. In addition, the equation in Brown et al. (1980) does not contain a substitute variable. Inclusion of such a variable would theoretically lower their benefit estimates somewhat. Recent work (Strong 1983) on steelhead fishing in Oregon, using a similar per capita TCM demand curve, yields a value of $22.95 per trip. This is between this study's two TCM estimates using standard and reported costs, respectively.

Comparison of Idaho TCM and CVM Estimates

The CVM value for a primary purpose trip is the appropriate CVM value for comparison to TCM values, because TCM is based on only primary purpose-primary destination trips. The mean value for CVM was $31.45, with a 95% confidence interval of $25.31 to $37.58. And, as reported earlier, when cost per mile is set at a standard cost, the TCM value per trip is $19.89 with a sensitivity interval of $15.27 to $23. When cost per mile is set at reported cost, the TCM value per trip is $27.87 with a sensitivity interval of $23.12 to $34.80.

Figure 4 shows how the sensitivity interval around the TCM value with reported cost overlaps the mean of CVM and vice versa. Thus, there appears to be no qualitative difference between the CVM value of $31.46 per trip and the TCM value of $27.87 per trip associated with actual reported cost per mile. The dollar value of $19.89 for TCM with standard cost per mile is lower than either the CVM or TCM value that are both based on reported cost per mile.

Comparison of TCM and CVM for the 11 individual sites shows a less consistent pattern. Using the TCM values associated with reported cost, the TCM and CVM values for site one and five are very close. For site 10, which received half the visits in the sample, the TCM values and the CVM values do not appear significantly different. For this most highly used site the two TCM values bracket the CVM values at about ±$4.00.

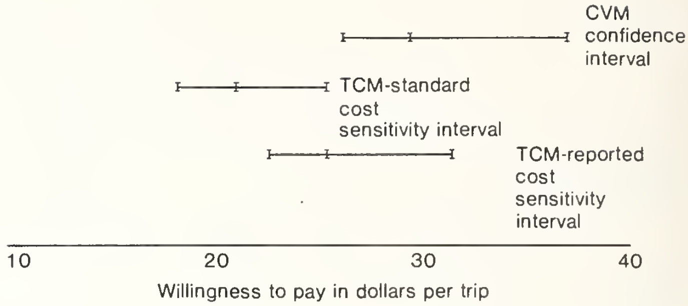
One reason the overall values for CVM are higher than those for TCM is that CVM values are for the anglers' last trip while TCM applies to all trips taken during the season. The key is that the distribution of trips across sites is slightly different in TCM and CVM. Making the distribution of trips more consistent between CVM and TCM may provide a more accurate way to compare TCM and CVM values per trip. For example, adjusting the distribution of CVM trips for sites 6, 7 and 10 to be more consistent with TCM trips and recalculating the overall mean CVM values for all 11 sites gives $25.63 per trip. This is almost identical to the TCM value of $27.87 using reported cost and much closer to the TCM values associated with standard cost.

Application

A comprehensive case study example that incorporates effects "with" and "without" the proposed management action, that goes into detail about benefit values and costs, and that considers discount rates and net present values is beyond the scope of this bulletin. However, some approaches to the use of these value estimates are illustrated here.

Suppose a combination of management practices in all steelhead areas is estimated by fisheries biologists to result in a doubling of the steelhead population (after a certain time lag).[8] The biologists further estimate that

[8]*Our example implies that changes may occur over several years. To keep the concepts clear, we have not considered present values and discounting. However, these effects may need consideration in actual practice.*



[1] l - lower value of interval
m - mean value of interval
u - upper end of interval

Figure 4.—Comparison of confidence intervals for CVM to sensitivity intervals for TCM.

the doubling of the population would double the catch. Thus, over the course of time needed to increase the number of steelhead, the total harvest also increases. Increased harvest is a positive factor in equation [5], the demand curve for trips per capita discussed in this bulletin, because it is associated with increased visits to the fishing site. When the individual demand curves showing trips per capita to a site are summed over all origins to gve the overall demand curve for the fishing area, the consumer surplus benefits associated with more visits also increases.

Computation Based on Theory

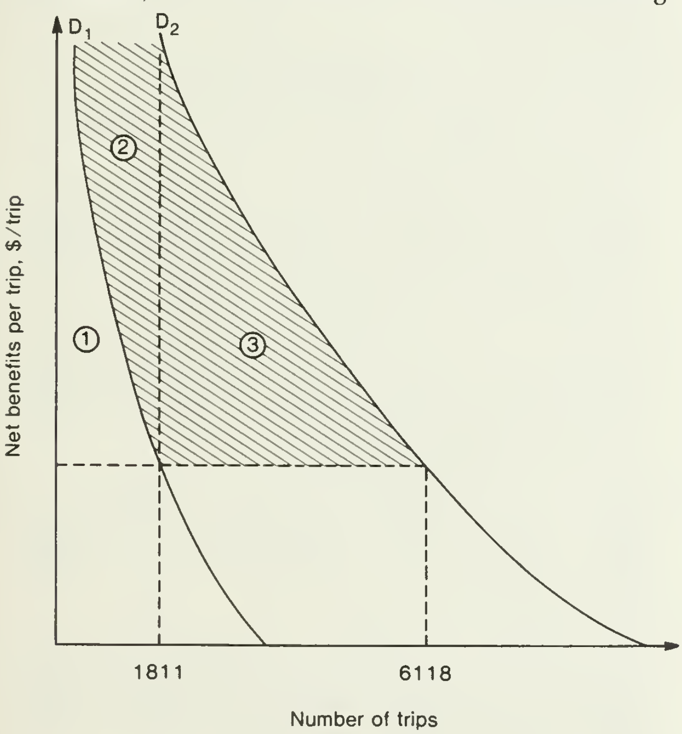
Because total catch at a fish area is a demand curve shifter in this travel cost model, doubling this variable (because of the increased population of catchable steelhead) shifts the demand curve up and to the right. This can be seen as the shift from D1 to D2 in figure 5, and assumes that coefficients in the demand curve equation are stable over the range of such changes. The improvement in fishing over the long run will be translated (in TCM) into more trips taken by existing anglers and entry (or reentry) of new anglers because of the higher quality fishing experience. Based on the sample for this study, use of the per capita demand curve (equation [5]) and the benefits computation procedures described in this report show that current and new anglers would make an additional 4,307 trips per year (6,118–1,811) to Idaho steelhead areas.

Long run value means the value once anglers have an opportunity to adjust their behavior (entry of new anglers and more trips by existing anglers). The theoretical measure of the net economic value of the additional 4,307 trips is equal to the shaded areas between the two demand curves (areas 2 and 3 in fig. 5). For the anglers in this sample (i.e., considering only those anglers sampled and not inflating the sample to the population of steelhead anglers fishing in Idaho), computation of the benefits shows they would be willing to pay an additional $117,751 for double fish catch. This is the long run sample value, which would be expanded by

a factor of approximately 59 to apply to all steelhead anglers fishing in Idaho. This economic value of improved steelhead fishing (more than $6.9 million for all steelhead anglers if the improvement were made uniformly at every site in Idaho) would be compared to the net economic value of any foregone benefits of the management program and its cost. If the net economic value of what is gained (i.e., more than $6.9 million in the hypothetical example) is greater than what was lost, economic efficiency is improved.

An Approximation to Theory

Biologists often are able to translate the change in fisheries habitat or populations into an estimate of the increase in supply of fishing trips of constant quality. However, in field studies, it is often difficult for biologists to have access to the original TCM data, the TCM demand curve, and a computer program to calculate benefits of a quality induced change in net economic benefits. Thus, the correct way to compute the consumer surplus measure of value of such changes (i.e., to sum the additional consumer surplus generated by each successive additional trip), may not be technically feasible under field conditions. Despite this, based on results in this bulletin, the economic benefit of the added fishing trips can be approximated by multiplying the increase in number of trips times the marginal value per trip. The marginal value may be unavailable. Given that the geographic scope is comparable and appropriate, use of the average value in place of marginal value is possible, because the functional form of the demand curve used for steelhead fishing is such that the consumer surplus average value equals its marginal value. While this is the case for semi-log functional forms, as is discussed more fully in the appendix, it is not generally true for other functional forms. Mumy and Hanke (1975) analyzed a situation where an average value could correctly be used.[9] Figure 5 shows there is a demand for 4,307 additional trips. Taking this number of trips times the average net value (prior to the management change) of $27.87 per trip, yields $120,036. In this case, the approximation to the area between the demand curves is a good one (i.e., a computed value of $117,751 based on theory).



① Area 1 is the original estimate of consumer surplus.

② After the change, area 2 is the increased benefits estimated by CVM in the short run.

③ In the long run, areas 2 and 3 are the total increased benefits estimated by TCM.

Figure 5.—Relationship of benefits estimated by TCM and CVM for increases in fish catch.

Short Run Benefits

Benefits of improved fish habitat do not necessarily flow only from more angler days in the long run. The increase in harvestable populations of fish may be received in the short run by current anglers. It may take several years before anglers believe the initial steelhead population change is permanent. It may take more time for informal information to spread from current anglers to potential anglers (those that are considering the sport and those that dropped out because fishing quality was not up to their expectations). As a result, the benefits of the improvement initially might be limited to current anglers. To estimate the value to current anglers, assuming no entry of new anglers, the analyst can use net economic values provided by the Contingent Value Method. In figure 5, this is area 2 between the demand curve and the vertical dashed line, showing that trips are held constant at the original level (1,811). In this steelhead study, anglers were asked in the CVM portion of the survey their willingness to pay for an increased probability of success that would result in double the number of fish caught. Mean responses of anglers indicated a total bid of $41.36 for the described increase. This is an increase of $9.91 over the bid for current conditions. Thus, the increase in net value in the short run would be about $18,000 (1,811 present trips × $9.91) for the sampled population.

CONCLUSIONS

TCM values using reported transport cost probably are more accurate in the case of steelhead fishing than a standard transport cost. Pickup trucks with campers and boat trailers are perceived by some as typical transport for many steelhead fishermen. Only the reported cost for these vehicles would reflect these higher costs.

[9] *John B. Loomis and John G. Hof expand on this theme in a forthcoming article, "A Note on the Comparability of Market and Nonmarket Valuations of Forest and Rangeland Outputs."*

The choice of which value, TCM or CVM, is better, is subjective. The TCM is representative of both spring and fall, whereas the CVM just represents fall fishing, because most anglers last trips were for fall fishing. Therefore, the value to use (TCM at reported cost or CVM) is the one that is most appropriate to the issue under study.

The Travel Cost and Contingent Value Methods used in this study each have advantages and disadvantages. The advantage of CVM is the ability to value not only primary purpose-primary destination trips but also multiple destination trips. For steelhead fishing in Idaho this is not a large advantage, because only 3% of the trips were not primarily for steelhead fishing. For other activities, this advantage may be more important. In addition, CVM provides reasonable values for changed conditions, such as doubling the number of fish or increasing fish size. There appears little trouble in getting people to participate in the bidding game. One limitation of CVM in this study was that it could reasonably be applied only to the last trip taken, because applying the bidding sequence to each trip would have doubled the length of the interview and involved greater difficulty in respondent recall. This limitation may not be too serious if the last trip is representative of the typical trips taken.

The primary advantages of TCM relate to its reliance on actual behavior and applicability to all trips taken during the season. Disadvantages relate to inability to value multiple purpose or multiple destination trips, and in selecting a value of travel time. TCM has the advantage of being able to predict how many additional trips (or with some additional calculations, fishermen), would be taken if the number of steelhead harvested doubled.

Perhaps the biggest practical disadvantage to the Travel Cost Method is the time it takes to construct a Regional Travel Cost Model (10–14 person days). The analysis work also involves use of several specialized computer programs designed to shorten the time necessary to aggregate individual data into zones, calculate substitute indices, calculate second stage demand curve, and benefits. If such programs are not available, then significant additional time is necessary.

In contrast, the CVM analysis of mean willingness to pay took about 1.5 person-days. Thus, if a survey must be performed to collect data for valuation, CVM is faster in terms of data compilation and statistical analysis. However, if origin-destination data already exist in the form of permits or license plate numbers, etc., then TCM would become a more cost-effective way to value recreational activities.

Each method yields consistent results. However, differing circumstances of application of results, of data availability, personnel, and time will determine which method is preferable.

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APPENDIX

Steelhead Survey Questionnaire

The survey of steelhead anglers fishing in Idaho was originated, developed, and administered by personnel from the Idaho Department of Fish and Game, and the University of Idaho Cooperative Wildlife Unit. In the interest of making complete information available, the text of the survey instrument is reproduced here with permission of the Idaho Department of Fish and Game.

SCRIPT FOR TELEPHONE INTERVIEW OF IDAHO STEELHEAD FISHERMEN
IDAHO DEPARTMENT OF FISH AND GAME

INTRODUCTION

HELLO, IS THIS THE RESIDENCE OF ______________________________?
first and last name

If yes. If no, → THE NUMBER I WAS CALLING IS ______________________________
telephone number

AND I AM TRYING TO CONTACT ______________________________, SORRY I

BOTHERED YOU. (TERMINATE, CHECK NAME AND NUMBER.)

→ THIS IS ______________________________ AT THE UNIVERSITY OF IDAHO. I
interviewer's name

AM CALLING FOR THE COLLEGE OF FORESTRY, WILDLIFE AND RANGE SCIENCES IN MOSCOW. WE ARE DOING A STUDY OF STEELHEAD FISHING IN IDAHO. WE ARE TRYING TO DETERMINE THE ECONOMIC VALUE OF IDAHO'S WILDLIFE. ______________________________'S
first & last name

NAME WAS GIVEN TO US BY THE IDAHO DEPARTMENT OF FISH AND GAME. IS HE/SHE THERE? MAY I SPEAK TO HIM/HER?

1. Respondent is on the phone
2. Respondent is called to phone
3. No

WHEN MAY I CALL BACK TO REACH HIM/HER? ____________ AND
date

____________ A.M./P.M. WOULD YOU TELL HIM/HER THAT I CALLED
time

AND THAT I WILL CALL BACK. THANK YOU.

→ THIS IS ______________________________ AT THE UNIVERSITY OF IDAHO. I AM
interviewer's name

CALLING FOR THE COLLEGE OF FORESTRY, WILDLIFE AND RANGE SCIENCES IN MOSCOW. WE ARE DOING A STUDY OF STEELHEAD FISHING IN IDAHO. WE ARE TRYING TO DETERMINE THE ECONOMIC VALUE OF IDAHO'S WILDLIFE. YOUR NAME WAS OBTAINED FROM THE IDAHO DEPARTMENT OF FISH AND GAME'S LISTS OF LICENSE HOLDERS.

→ LAST WEEK WE SENT YOU A LETTER AND MAP THAT EXPLAINED A LITTLE ABOUT OUR STUDY. DID YOU RECEIVE IT?

yes

no I AM SORRY YOURS DID NOT REACH YOU. IT WAS A BRIEF LETTER WE SENT SO THAT PEOPLE WOULD KNOW WE WOULD BE CALLING THEM.

1. DID YOU FISH FOR STEELHEAD IN IDAHO DURING 1982?

no THANK YOU FOR YOUR HELP. THAT IS ALL THE QUESTIONS THAT I HAVE FOR YOU.

yes

(skip this question if they did not receive the letter).

2. DID YOU HAVE TIME TO LIST ALL THE STEELHEAD FISHING TRIPS YOU TOOK DURING 1982 ON THE MAP WE SENT YOU?

yes WOULD YOU READ ME YOUR LIST OF FISHING AREA NAMES AND THE CORRESPONDING MAP UNIT NUMBERS.

RECORD LIST ON SEPARATE SHEET
go on to probes at bottom of page.

no

ON A PIECE OF PAPER, PREFERABLY THE ONE WE SENT TO YOU IN THE MAIL, LIST ALL THE STEELHEAD FISHING TRIPS YOU TOOK THIS PAST SEASON. A LIST OF GENERAL LOCATIONS IS FINE. OUR GOAL IS NOT TO FIND OUT YOUR SPECIAL SPOTS. IN ADDITION TO THIS LOCATION, IF YOU HAVE THE MAP WE SENT, PLEASE DETERMINE THE MAP UNIT WHERE YOU WENT ON EACH TRIP. PLEASE TAKE A MOMENT TO MAKE YOUR LIST OF FISHING AREAS AND CORRESPONDING MAP UNITS. IF YOU WENT TO ONE AREA MORE THAN ONCE, JUST LIST THE AREA AND NUMBER OF TRIPS.

Pause while he/she completes the list. Try to get them to make their own list. You may write the list if they do not have paper or refuse to write it out.

WOULD YOU READ ME YOUR LIST OF FISHING TRIPS.

NOTE 1. If an interviewee does not have a map, it is your duty to get enough information to assign a map unit number to each general location.

NOTE 2. Probe: DID YOU INCLUDE TRIPS YOU TOOK WITH YOUR FAMILY, VISITING RELATIVES, FRIENDS, OR PEOPLE YOU WORK WITH?

NOW THAT WE KNOW HOW MANY TRIPS AND IN WHAT MAP UNIT YOU TOOK THEM, I WOULD LIKE TO ASK YOU SOME MORE DETAILED QUESTIONS ABOUT EACH TRIP. IF

YOU MADE MORE THAN ONE TRIP TO AN AREA, PLEASE GIVE THE AVERAGE FOR THOSE TRIPS.

WAS THE PRIMARY PURPOSE OF YOUR TRIP TO ______________________________
general area

TO FISH FOR STEELHEAD?

yes

no → (terminate and start new area)

maybe → WOULD YOU HAVE VISITED THIS AREA IF STEELHEAD FISHING WAS NOT AVAILABLE?

yes → (terminate and start new area)

no

→ WAS THIS AREA THE PRIMARY DESTINATION OF THIS TRIP?

yes → (enter a "1")

no

maybe → WOULD YOU HAVE MADE THIS TRIP IF YOU COULD NOT HAVE VISITED THE AREA?

no

→ yes → HOW MANY DESTINATIONS DID YOU HAVE ON THIS TRIP?

______________ AREAS

WHAT WERE THOSE DESTINATIONS?

→ HOW MANY TRIPS DID YOU MAKE TO ______________________________
general area

DURING THE SPRING SEASON? ______________ TRIPS

HOW MANY TRIPS DURING THE FALL SEASON? ______________ TRIPS

DID YOU DRIVE THE ENTIRE DISTANCE TO ______________________________?
general area

yes → mode = 1

no → WHAT DIFFERENT TYPES OF TRANSPORTATION DID YOU USE?

small plane, airline, horse, car, jet boat, etc.

FOR YOUR TRIP TO ______________________, WHAT WAS THE APPROXIMATE

TOTAL DISTANCE YOU TRAVELED?

COUNTING YOURSELF, HOW MANY LICENSED ANGLERS WENT IN YOUR VEHICLE TO

______________? ______________anglers
general area

HOW MANY UNLICENSED CHILDREN FISHED? ______________ children

HOW MANY DAYS DID YOU FISH ON THIS TRIP TO ______________________________?
general area

(TO NEAREST HALF DAY)

ON AVERAGE, HOW MANY HOURS PER DAY DID YOU FISH?

______________ hours

ON AVERAGE, HOW MANY DID YOU CATCH PER DAY INCLUDING THOSE YOU DID NOT

KEEP? ______________________

If this is the last area, go on to page 5.
If there are more areas, repeat from page 3 with other areas.

THAT IS ALL I NEED ABOUT THIS AREA, NOW I WOULD LIKE TO TALK ABOUT YOUR

TRIPS TO ______________________
general area

go back

NEXT, I WOULD LIKE TO ASK YOU SOME QUESTIONS ABOUT YOUR LAST STEELHEAD

FISHING TRIP IN 1982. WHAT AREA DID YOU VISIT ON YOUR MOST RECENT TRIP?

______________ area

WAS THE PRIMARY PURPOSE OF YOUR TRIP TO ______________ TO
general area

FISH FOR STEELHEAD?

yes

no

WAS THIS AREA THE PRIMARY DESTINATION OF THIS TRIP?

record response as follows:

If "Primary purpose?" is

	yes	no
yes	1	2
no	3	4

HOW MANY LICENSED ANGLERS WERE IN YOUR PARTY?

______________ people

HOW MANY DAYS DID YOU FISH ON THIS TRIP (TO NEAREST HALF DAY)?

______________ days

ON AVERAGE, HOW MANY HOURS DID YOU FISH EACH DAY?

____________________ hours

THE NEXT FEW QUESTIONS CONCERN THE AMOUNT OF MONEY THAT WAS YOUR SHARE OF THE AMOUNT SPENT ON THIS TRIP.

PLEASE ESTIMATE THE AMOUNT SPENT ON TRANSPORTATION ON THIS TRIP.

$ ____________________

PLEASE ESTIMATE THE AMOUNT SPENT ON FOOD, TACKLE, ETC. ON THIS TRIP.

$ ____________________

NOW, ESTIMATE THE AMOUNT SPENT ON ACCOMMODATIONS ON THIS TRIP.

$ ____________________

WAS THIS TRIP TO ____________________ WORTH MORE THAN YOU ACTUALLY SPENT?

no → STOP HERE

yes

→ NEXT, I WOULD LIKE TO ASK SOME HYPOTHETICAL QUESTIONS ABOUT THIS TRIP TO ____________________ (general area), ASSUME THAT THE TRIP BECAME MORE EXPENSIVE, PERHAPS DUE TO INCREASED TRAVEL COSTS OR SOMETHING, BUT THE GENERAL STEELHEAD FISHING CONDITIONS WERE UNCHANGED. YOU INDICATED THAT $ ____________________ WERE SPENT ON THIS TRIP FOR YOUR INDIVIDUAL USE.

WOULD YOU PAY $ ____________________ (20% of cost) MORE THAN YOUR CURRENT COST RATHER THAN NOT BE ABLE TO FISH FOR STEELHEAD AT THIS AREA?

PROTEST – WILL NOT ANSWER

RECORD WHY?

1. it's my right
2. my taxes already pay for it
3. no extra value
4. like to, but not able
5. refuse to put a dollar value

yes

no → work between 0 and 20% to find highest acceptable value. split the difference in half until you reach nearest $1 (less than $10) or nearest $5 (greater than $10)

→ WOULD YOU PAY $ ________________ MORE THAN YOUR CURRENT COST RATHER THAN NOT BE ABLE TO FISH FOR STEELHEAD AT THIS AREA.

yes

no → Work between 20 and 50% to find highest acceptable value. split the difference in half until you reach nearest $1 (less than $10) or nearest $5 (greater than $10).

→ WOULD YOU PAY $ ________________ MORE THAN YOUR CURRENT COST RATHER THAN
100% of cost
NOT BE ABLE TO FISH FOR STEELHEAD AT THIS AREA?

yes

no → work between 50 and 100% to find highest acceptable value. split the difference in half until you reach nearest $1 (less than $10) or nearest $5 (greater than $10).

keep going until you receive a negative answer. Use 100$ increments.

work between last two bids to find highest acceptable value.

After last bid

IS THIS AMOUNT, $ ________________, WHAT YOU PERSONALLY WOULD PAY, NOT FOR ALL
bid
MEMBERS OF YOUR PARTY?

no → repeat bids for personal value

yes

→ HOW MANY STEELHEAD DID YOU CATCH ON THIS TRIP TO ________________?
general area

________________ fish

NOW SUPPOSE THAT INSTEAD OF ________________ STEELHEAD, YOU COULD CATCH
caught

________________ STEELHEAD. HOW MUCH, IF ANY, WOULD YOU INCREASE YOUR VALUE
double #

OF $________________?

$ ________________

NOW SUPPOSE, THAT THE SIZE OF FISH YOU CAUGHT INCREASED 50% (FOR EXAMPLE, FROM 8" TO 12". HOW MUCH, IF ANY, WOULD YOU INCREASE YOUR VALUE OF $ ________________?

$ ________________

THAT IS ALL THE QUESTIONS I HAVE FOR YOU. THANK YOU FOR TAKING THE TIME TO ANSWER THESE QUESTIONS. YOUR RESPONSES WILL BE VERY VALUABLE TO US. GOODBYE.

Average and Marginal Consumer Surplus – Conditions of Equality

The objective of the proof is to show that average benefits are equal to marginal benefits in relation to the per capita (stage I) demand curve. The means to accomplish this is to derive the mathematical expression for the benefits in each case and to show these are equal. The conditions under which this is true are:

1. Demand relationships between visits per capita and price (cost of travel) can be validly modeled with a semi-log functional form such as

$$\ln(q) = a - bp \qquad [A1]$$

or equivalently,

$$q = e^{a-bp} \qquad [A2]$$

where q is quantity, in this case, visits per capita
p is price, in this case, travel cost
a is the intercept parameter
b is the slope parameter

2. The only shifting variables allowed in the equation affect the intercept. No slope shifting variables are in the equation.
3. A slight relaxation of condition 2 occurs if there are slope shifting variables but they do not change from the "before" to the "after" states.
4. Each origin is a price taker in that people from that origin may visit the site as many times as they desire at their current travel cost. Therefore, the supply curve facing a given origin is horizontal. Due to differences in location from the site, each origin faces a different horizontal supply curve.

The "Before" State

Figure A–1 shows the overall scope of the changes considered in the proof. At equilibrium in state 1 (i.e., the "before" state) the demand curve has a quantity intercept of e^{a_1} when price is zero. As price increases, quantity decreases and asymptotically approaches zero for very large p. For a price of p_1, visits per capita to a site from a specific origin are q_1.

Total benefits per capita that accrue to the presence of the site, given all other existing sites, are represented by the shaded area labeled CS_1 (consumer surplus in state 1). This area is found by integrating under the demand curve and above the price line p_1.

Let a small segment of the area dCS be

$$dCS = q\,dp \qquad [A3]$$

as shown in figure A–1.
Then

$$CS = \int dCS = \int_{p_1}^{p} q\,dp \qquad [A4]$$

The limits of integration define the lower boundary of the CS area, the p_1 price line, and the upper boundary of the

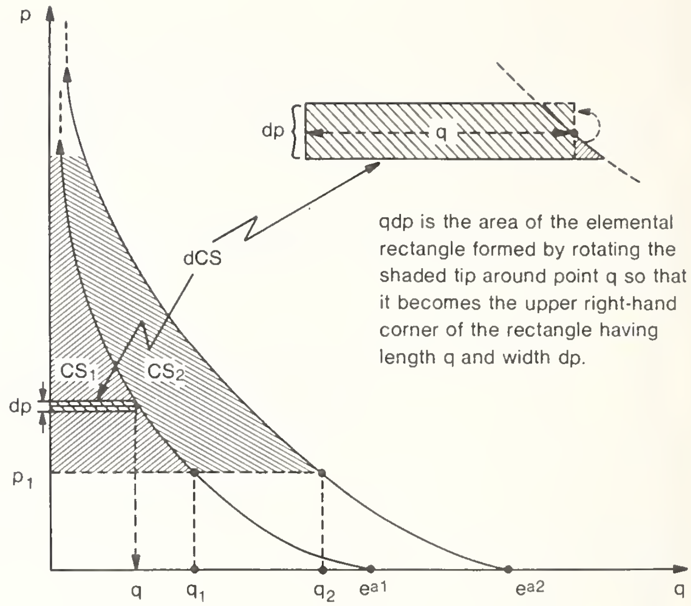

Figure A-1.—Changes in consumer surplus.

CS area, the point where p goes to infinity and q goes to zero. In spite of these extreme values, it turns out the CS area is finite.

Substitute for q from equation [A2] in the integral in equation [A4] giving

$$CS_1 = \int_{p_1}^{p} e^{a_1 - b_1 p}dp \qquad [A5]$$

where the subscript 1 denotes state one ("before"). Continuing with the integration gives

$$CS_1 = e^{a_1} \int_{p_1}^{p} e^{-b_1 p}dp = -\frac{1}{b_1} e^{a_1 - b_1 p} \Big|_{p_1}^{p} \qquad [A6]$$

Evaluating the expression in [A6] at the limits of integration gives

$$CS_1 = \left(-\frac{1}{b_1} e^{a_1 - b_1 p}\right) - \left(-\frac{1}{b_1} e^{a_1 - b_1 p_1}\right) \qquad [A7]$$

$$CS_1 = \frac{1}{b_1}\left(e^{a_1 - b_1 p_1} - e^{a_1 - b_1 p}\right) \qquad [A8]$$

In order to include the entire area under the demand curve, let p (not p_1) become infinitely large ($\rightarrow \infty$). For large p

$$e^{a_1 - b_1 p} = q \rightarrow 0 \qquad [A9]$$

so that expression for CS in [A8] becomes

$$CS_1 = \frac{1}{b_1}\left(e^{a_1 - b_1 p_1}\right) = \frac{q_1}{b_1} \qquad [A10]$$

Average consumer surplus in state one per trip made (q_1) is

$$\overline{CS_1} = \frac{CS_1}{q_1} = \frac{1}{b_1}\left(e^{a_1 - b_1 p_1}\right)\frac{1}{q_1} \qquad [A11]$$

But $e^{a_1 - b_1 p_1}$ is q_1, so

$$\overline{CS_1} = \frac{1}{b_1} \qquad [A12]$$

Thus, average consumer surplus per trip in state one, the "before" state, is simply the inverse of the slope parameter from the demand equation, assuming the conditions previously stated are met.

The "After" State

Now, assume that managers of the recreational sites under consideration wish to increase the attractiveness of the specific site, for example, by increasing the number of animals or fish potentially harvestable. This new condition becomes the "after" state.

The new attractiveness at the site increases the intercept to e^{a_2}, but does not affect the slope coefficient b, as assumed, so $b_1 = b_2 = b$, (i.e., quality is an intercept shifter only). Using the result of the previous section, that, in general under the stated conditions,

$$CS = \frac{1}{b}\left(e^{a - bp}\right) = \frac{q}{b} \qquad [A13]$$

and placing the subscript (2) for the "after" state on the variables, total per capita consumer surplus for the "after" state is

$$CS_2 = \frac{1}{b_2}\left(e^{a_2 - b_2 p}\right) = \frac{q_2}{b_2} \qquad [A14]$$

Note that "after" average CS is also $\frac{1}{b_2} = \frac{1}{b}$.

The total change in consumer surplus from the "before" to the "after" state is

$$\Delta CS = CS_2 - CS_1 \qquad [A15]$$

$$\Delta CS = \frac{q_1}{b_2} - \frac{q_2}{b_1} \qquad [A16]$$

But, as noted, $b_2 = b_1 = b$, so

$$\Delta CS = \frac{q_2 - q_1}{b} \qquad [A17]$$

The marginal change per unit increase in trips is defined as

$$\frac{\Delta CS}{\Delta q} = \frac{\frac{q_2 - q_1}{b}}{q_2 - q_1} \qquad [A18]$$

So

$$\frac{\Delta CS}{\Delta q} = \frac{1}{b} \qquad [A19]$$

And since $b = b_1 = b_2$, combine the results of the derivation of "before" average consumer surplus and the derivation of the marginal consumer surplus caused by the change to the "after" state.

Thus,

$$\overline{CS_1} = \frac{1}{b} = \frac{\Delta CS}{\Delta q} = CS_{marg} = \overline{CS_2} \qquad [A20]$$

and the proof is complete given that the preceding conditions are met.

Note in the proof that the relationship in equation [A20] does not depend on the price level, even though figure A1 shows price unchanging. Neither do the key equations for "before" and "after" consumer surplus, equations [A10] and [A14], respectively. Under the stated conditions, there may or may not be a price change along with the demand curve shift. Regardless, it does not affect the equality between the "before" average consumer surplus and the "before" – to – "after" marginal change in consumer surplus. Moreover, the price may change in either direction without affecting the results.

GPO 846-592

Donnelly, Dennis M., John B. Loomis, and Cindy F. Sorg. 1984. Net economic value of recreational steelhead fishing in Idaho. USDA Forest Service Resource Bulletin RM-9, 23 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Willingness to pay in addition to actual expenditure for steelhead fishing in Idaho was estimated at $27.87 per trip with the Travel Cost Method and at $31.45 per trip with the Contingent Value Method. Willingness to pay was greater for increased catch or fish size. Average actual expenditure was $72 per trip.

Keywords: Steelhead fishing, economic value, travel cost method, contingent value method, recreation

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U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

Rocky Mountains

Southwest

Great Plains

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

RESEARCH FOCUS

Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

RESEARCH LOCATIONS

Research Work Units of the Rocky Mountain Station are operated in cooperation with universities in the following cities:

Albuquerque, New Mexico
Flagstaff, Arizona
Fort Collins, Colorado*
Laramie, Wyoming
Lincoln, Nebraska
Rapid City, South Dakota
Tempe, Arizona

*Station Headquarters: 240 W. Prospect St., Fort Collins, CO 80526